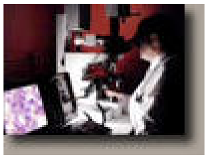

Medical Actinium Therapeutic Treatment (MATT) Technology: Medical isotope advances cancer treatment

For decades, medical researchers have sought treatments for cancer. Now, Alpha Particle Immunotherapy offers a promising treatment for many forms of cancer, and perhaps a cure.

Unfortunately, the most promising alpha-emitting medical isotopes, actinium-225 and its daughter, bismuth-213, are not available in sufficient quantity to support current research, much less therapeutic use. In fact, there are only three sources in the world that largely "milk" these isotopes from less than 2 grams of thorium source material. Additional supplies were not forthcoming.

Fortunately, scientists and engineers at Idaho National Laboratory identified 40-year-old reactor fuel stored at the lab as a substantial untapped resource and developed Medical Actinium for Therapeutic Treatment, or MATT, which consists of two innovative processes (MATT-CAR and MATT-BAR) to recover this valuable medical isotope.

Both MATTs can make 100 times more source material available, significantly increasing world supplies, enabling clinical trials to proceed, and making high-volume therapeutic use a potential reality.

Both processes start with reactor fuel pellets that are 3% uranium-233 and 97% thorium-232. Over time, small amounts of U-233 decay into thorium-229. This more rare thorium is the parent of the desired medical isotope actinium-225.

Over decades of storage, this decay process has spawned roughly 50 grams of thorium-229, contained in 13 metric tons of fuel. To separate out this fine amount of material, both processes begin by dissolving these nuclear fuel pellets in acid.

Once in solution, the Continuous Actinium Recovery or MATT CAR process illustrated in this animation uses a liquid-liquid separation. The aqueous phase acid solution of uranium and thorium is brought into contact with the organic (nonaqueous-phase) liquid.

The two phases are mixed and separated using a centrifugal contactor technology previously developed and commercialized by INL researchers. Using this process, uranium and thorium are transferred into an organic phase that is stored for the wash step.

In the contactor, the desired medical isotope, actinium-225 and its progenitor radium-225, are washed in a relatively small volume of nitric acid solution. The uranium and thorium remain in the organic phase.

On a monthly basis, the nitric acid wash solution containing actinium and radium is processed through a separation column which selectively binds actinium. The radium parent is recycled through the column for additional medical isotope recovery.

This entire process from start to finish is a closed loop with uranium and thorium in the system continuously, giving rise to more actinium. The nitric acid wash solutions are recycled in and out of service each month.

The uranium-233 continues to decay to thorium-229, resulting in the source material continually growing in to the solution. This means world isotope supplies grow by 3% each year.

The second process, called the Batch Actinium Recovery or MATT BAR process, uses a precipitation method to isolate thorium and then wash it to extract actinium for capture on a column.

Once again, separated actinium can easily be stripped from the column and readied for shipment to awaiting medical facilities.

For both processes, the column recovery and separation of actinium-225 from impurities is compatible with the medical requirements of the customer.

This pair of MATT technologies offers a breakthrough for producing a promising medical isotope that is in extremely short supply. This breakthrough will make continued and expanded clinical cancer treatment trials possible.

Importantly, after successful trials, MATT processes generate enough source material to support hundreds of thousands of patients each year. MATT technology cures two problems – reducing expensive storage of nuclear materials and creation of medical isotopes for cancer trials and treatments. A true win-win for the Department of Energy and those suffering from the ravages of cancer.